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That this is the proper order of psychic evolution may be inferred from two considerations. (1) The sensations due to pressure, light, heat, hunger, etc. are experienced by animals of low as well as of high organization. (2) The order of structural evolution is from the homogeneous to the heterogeneous, or from the generalized to the specialized.—E. D. COPE.

MICROSCOPY.

Formal,[1] (Formaldehyde 40 per cent. solution).—Practical experience with Formal in the Laboratory. By Bert B. Stroud, D. Sc., Instructor in Physiology, Vertebrate Zoology, and Neurology. Cornell University, Ithaca, N. Y.

During the past two years much interets has been shown concerning formaldehyde, as an agent for hardening and preserving anatomic material. An extensive literature has arisen, which as Lee[2] has observed, is sadly confused by the indiscriminate and incorrect use of the terms *Formol* and *Formalose.* The term *formol* is a very bad one. Because according to the principles of chemical terminology the suffix *ol* is applied to a different class of compounds, examples of which are alcohol, glycerol, and phenol.

The molecular structure of the aldehydes differs from that of the examples given.

Formalose might be confused with *formose,* a mixture of carbohydrates made from formaldehyde. *Formalin* is a term which has no meaning.

We have to deal with a definite chemical individual; why then should it not be called by its own proper name or by a suitable contraction of that name? It may be urged since the commercial product is a solution of gaseous formaldehyde in water, that the name should indicate such solution. But the term *hydrochloric acid* is an excellent precedent for saying formal or formaldehyde, since the acid of the laboratory is a solution of the gas HCl in water. But every one calls the solution hydrochloric acid.

[1] The term *Formaldehyde* is a cumbersome one. Professor W. R. Orndorff has suggested that *Formal,* from *Formal-dehyde* is the best scientific contraction. The term *Methanal,* for formaldehyde, was adopted by the Geneva Congress of Chemists.

[2] Formol or Formaldehyde? *Anatomischer Anzeiger. XI, No. 8, October 24, 1895, S. 255–256.*

The strength of the 40 per cent. solution of formal is subject to some variation, since on standing for a long time it deposits a precipitate of metaformal and the solution is weakened by the amount of formal precipitated. Metaformal may also be obtained, as a bluish-white amorphous powder on simple evaporation of the commercial 40 per cent. solution. This amorphous form is readily soluble in water heated to 60°-70° C. It can be easily manufactured and would soon become a commercial article if there were a demand for it. The writer suggests that this would be the most convenient and economical way to use formal. Solutions of definite strength could be easily prepared, by simply weighing the proper amount and dissolving it in water heated to 70° C. Considerable expense for packing and transportation would be avoided.

Action of formal on animal substances.—The writer is inclined to believe that the action of formal varies with the kind of tissue, its source, whether from an aquatic or a terrestrial vertebrate, and the period of immersion in the liquid.

1. *Action on white of egg.*—Six portions of 4 cc. each were treated with solutions of formal of the following strengths,—0.2 per cent.; 0.8 per cent.; 1.6 per cent.; 3.2 per cent.; 8 per cent.; 40 per cent. The mixtures were put into vials and tightly corked. A flocculent precipitate resulted. It was slight in the dilute solutions, but more copious in the bottle which contained the 40 per cent. formal. After 48 hours, the dilute solutions had assumed a translucent appearance but remained perfectly fluid. The 40 per cent. solution was of a jelly-like consistency and was more opaque than the weaker solutions.

2. The mucus of petromyzon, fishes, and necturi was coagulated; at first translucent, it finally became more or less opaque and sometimes could be peeled off from the skin.

The first general effect of formal on animal tissue is to coagulate the proteids; this fact probably accounts for its value in the Golgi method. Fats are apparently little altered. It has been used in this laboratory for the preservation of lampreys, Amia, and other fish-like vertebrates, of amphibia, reptiles, birds, mammals and of brains. The action on vertebrates up to and including amphibia has been more or less satisfactory. But the results upon muscles and viscera of reptiles, birds, and mammals where the specimens were immersed for four months or longer were far from being satisfactory. The action is rapid at first, then proceeds more slowly, several months being required to obtain the final effect. However, material for *immediate dissection*[4] may be kept in 2 per cent. formal (formal 2 cc., water 98 cc.).

[4] Material will keep quite well for four to six weeks.

Among the undesirable effects may be mentioned:

1. Swelling of tissue from absorption of water.
2. Partial solution of connective tissue elements.
3. Diminished elasticity, sometimes brittleness, of glands, ducts, and membranous viscera so that they may not survive the rough usage of the average beginner.
4. The action on tissues rich in proteids as muscles of the terrestrial vertebrates is something like dissociation. The connective tissue is either softened or dissolved so that the fasciculi and fibres are easily teased apart.
5. Muscles are shortened so that the limbs are usually flexed. If the limb is forcibly extended, either the muscles themselves or the tendons break. The dissection of individual muscles is liable to tear them. If the specimen has been in the fluid for several months, the muscles become rigid and brittle. If the limb be forcibly adducted, the humerus or femur will usually break. The separation of individual muscles and the demonstration of their actions are very difficult or even impossible.

In June, 1895, a lot of sea-lampreys were prepared by injecting 2 per cent. formal through the dorsal aorta. They were then put into 2 per cent. formal. The solution was changed three times and about Sept. 1, they were put into 50 per cent. alcohol. In Jan., 1896, the specimens had shrunken slightly. Preservation was fair, with the exception of a long longitudinal check in the axon (notochord) and the blood vessels did not show so well as in the previous year when alcohol was used for injection and preservation.

Brains.—Formal appears to be almost an ideal fixer and preservative for brains where gross morphology is the object. They are tough and flexible; the alba, cinerea, and fibre tracts are well differentiated. The natural color is more perfectly retained than where other agents are employed. But membranous portions, telas, and plexuses are not so well preserved as where alcohol is used.

The following mixture was satisfactorily employed for sheep brains—a 2 per cent. solution of formal:

Formal (40 per cent. solution) . .	20 cc.
Sodium chloride	46 grams.
Water	1000 cc.

After 5–8 days the specimens may go into 2.5 per cent. formal indefinitely.

Eyes.—Sheeps' eyes were well preserved in 2 per cent. formal; the cornea, lens, and vitreum had a more natural appearance but the lens, capsule, and recti muscles were much better preserved when alcohol was used.

The chief objections to formal are:

1. It does not preserve well the plexuses and membranous parietes of the brain.
2. It is in unstable chemical equilibrium.
3. The conditions attending its use are favorable to chemical change, *i. e.*, (a) solution, (b) moderate heat, (c) the presence of substances themselves in unstable chemical equilibrium.
4. The large excess of water present causes tissue to swell and aids in dissolving connective tissue.
5. The cost of a given solution is less than that of alcohol, but the renewal of solutions brings the total expense up to nearly that of alcohol free of tax; and in the writer's judgment, excepting for brains and perhaps for aquatic vertebrates, the final result is less satisfactory.

SUMMARY.

1. The most suitable contraction of the name *Formaldehyde* is *Formal. Formalin* is meaningless. *Formol* is incorrect. *Formalose* is misleading.
2. Some uniform standard for preparing solutions is desirable.
3. Formal is an unstable chemical compound. It polymerizes on standing. A precipitate of Para- and Metaformaldehyde, insoluble in water at ordinary temperatures, is formed and the solution is weakened by the amount of the precipitate.
4. Para- or Metaformal may be procured in the dry form and solutions can be prepared when desired by simply dissolving the required amount in hot water (70° C.). This would be the more economical way to use formal.
5. Formal coagulates proteids and dissolves connective tissue. The action proceeds slowly and the final effect is reached in about four months.
6. Solutions of formal will freeze so that it is unsafe for the storage of museum preparations.
7. Formal, as a general preservative for terrestrial vertebrates, is unsatisfactory.

Formal appears to give good results for:

a. The fixation and preservation of brains for the study of gross morphology and fissures.

b. For the preservation of the cornea and vitreum of the eye.

c. For the Golgi method of staining nerve cells.

d. For Weigert's method.
e. For the temporary preservation of anatomic material.
f. Perhaps for the preservation of aquatic vertebrates.
g. For hardening material in which the blood vessels have been injected with colored gelatin.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Boston Society of Natural History.—December 2d.—The following communications were made: "The Early Services of Mr. Thomas T. Bouvé to the Society," by Charles J. Sprague and James C. White; "Mr. Bouvé's Work in the Society Since 1870," by Alpheus Hyatt; "Mr. Bouvé's Work in Geology and Mineralogy," by W. O. Crosby.

December 16th.—The following papers were read: Prof. F. W. Putnam, "Statement Concerning Some Recent Discoveries at Trenton, N. J., Bearing Upon the Early Presence of Man in the Delaware Valley;" Prof. G. Frederick Wright, "The Extent of Preglacial Erosion in the United States, and its Bearing on the Question of the Length and Date of the Glacial Period."—Samuel Henshaw, *Secretary.*

American Philosophical Society.—December 18th.—Drs. W. H. Furness, 3d, and H. M. Hiller made a preliminary report on their explorations in Borneo and the Loochoo Islands.

University of Pennsylvania Biological Club.—December 7th. Program.—"Demonstrations of Some Mexican Plants," Dr. John W. Harshberger; "Demonstrations of Slides Showing Conjugation of Nuclei in the Intestinal Cells of Land Isopods," Dr. E. G. Conklin. Reviews: Botanical, Dr. J. M. Macfarlane, Dr. H. C. Porter; Chemical, Dr. Mary E. Pennington; Psychological, Dr. Lightner Witmer. Original Communications: "Diseased Action and Senility, Considered in Connection with Biological Work," Dr. J. H. Allen.

December 21st Program.—Demonstrations: Slides showing deformation of nuclei in the intestinal cells of Land Isopods, Dr. E. G. Conklin. Reviews: Botanical, Drs. Macfarlane, Harshberger, Porter; Chemical, Dr. Mary E. Pennington; Psychological, Dr. Lightner Witmer; Pathological, Dr. Ferree Witmer. Original Communications: "The Native Dahlias of Mexico," Dr. John W. Harshburger.—H. C. Porter, *Secretary.*